Taylor Larrechea
Jacob Doose
9-22-16

+8.5/10

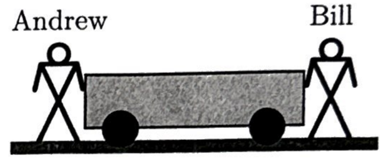
Phys 131L
Fall 2016

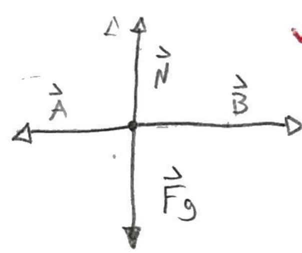
Laboratory 5: Introduction to Forces

Force, which is central to Newtonian mechanics, is used to describe interactions between pairs of objects. Unlike the colloquial usage of the word, force in Newtonian mechanics entails precise mathematical descriptions of interactions and their effects on the motion of objects. These exercises will help to to familiarize you with the precise language of force and to examine the relationship between force and motion.

1 Specifying Forces

a) A cart, whose wheels have a frictionless coating, is on a horizontal surface as illustrated. Two identical twins push on the cart in exactly the same way but from opposite directions. *List* the forces acting on the cart. For each force you must state which two objects are interacting and subsequently use the following language with blanks filled out: "_____ *exerts a* _____ *force on* _____."





$\vec{N}$ = Two objects are the ground and the tires

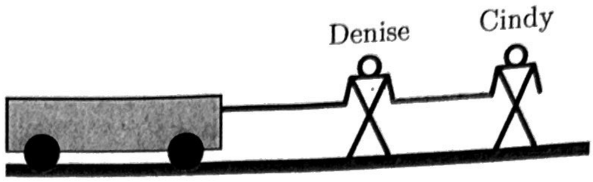
Andrew $\vec{A}$ = Two objects are Andrew and the cart — Andrew pushing on cart

Bill $\vec{B}$ = Two objects are bill and the cart — Bill pushing on cart

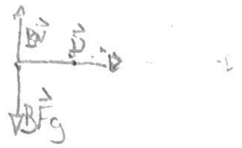
Force of Gravity $\vec{F_g}$ = Two objects are it's mass and acceleration

Gravity acting on cart

b) A tug-of-war team pulls on a cart, whose wheels have a frictionless coating, as illustrated. A black rope connects Denise and the cart while a gray rope connects Cindy and Denise.



i) Using the format of the previous question, list the forces acting on the cart.



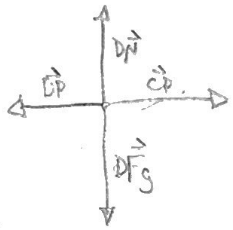
$B\vec{F_g}$ = Force of gravity on cart

$B\vec{N}$ = Normal force of the ground on the cart

$\vec{D}$ = Tension force of the rope on the cart exerted by Denise

$\vec{C}$ = Tension force of the rope on Denise exerted by Cindy

ii) List the forces acting on Denise.



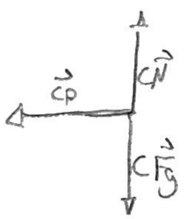
$D\vec{N}$ = Normal force of the ground acting on Denise

$\vec{F_g}$ = Force of gravity acting on Denise

$\vec{DP}$ = Tension Force of Denise pulling on the cart

$\vec{CP}$ = Tension Force of Cindy pulling

iii) List the forces acting on Cindy.



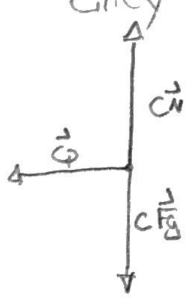
$C\vec{N}$ = Normal force of the ground acting on cindy

$\vec{CP}$ = Tension Force of cindy on Denise

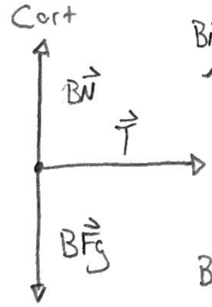
$C\vec{F_g}$ = Force of gravity acting on cindy

iv) For each of Denise, Cindy and the cart, draw a free body diagram.

Cindy



Cart

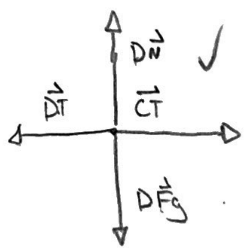


$B\vec{N}$ = Normal force of ground acting on cart

$\vec{T}$ = Tension force of the ropes on cart

$B\vec{F_g}$ = Force of gravity acting on the cart

Denise



$D\vec{N}$ = Normal force of ground acting on Denise

$\vec{DT}$ = Tension force of the rope acting on the cart

$\vec{CT}$ = Tension force of the rope acting on Denise

$D\vec{F_g}$ = Force of gravity acting on Denise

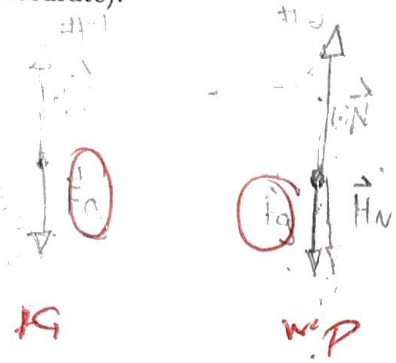
$C\vec{N}$ = Normal force of the ground acting on cindy

$\vec{CP}$ = Tension force of the rope acting on Denise

$C\vec{F_g}$ = Force of gravity acting on cindy

c) Two books are at rest on a horizontal table. *Hitchhiker's Guide to the Galaxy* lies on top of *War and Peace* which sits on the table. *War and Peace* is much heavier than *Hitchhiker's Guide to the Galaxy.*

i) Draw a free body diagram for each book as accurately as possible (ensure that the magnitudes and directions of the vectors relative to each other are accurate).



Hitchhikers Guide to the galaxy = 1

war of peace = 2

$\vec{WN}$ Normal force of the table on war and peace

$\vec{Fg} + \vec{HN} = \vec{WN}$

$\vec{Fg}$ = Force of gravity

SAME Fg ?

-1/2

ii) The author Tolstoy claims that "The mass of *Hitchhiker's Guide to the Galaxy* is a force that acts on *War and Peace*." Is this correct? Explain your answer.

iii) The author Douglas Adams states that there is only one force acting on *Hitchhiker's Guide to the Galaxy* and the only reason that it does not move is because *War and Peace* is in the way. Is this correct? Explain your answer.

No, there is a normal force of war and peace acting on Hitchhikers Guide to the Galaxy so therefore It does not move.

2 Forces and Motion

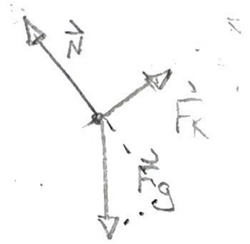
a) A brick is on a inclined surface as illustrated. The brick is at rest. *List* the forces acting on the brick using the format of part 1.

$\vec{N}$ = Normal Force of inclined surface acting on the brick

$\vec{F}_k$ = Friction force of the surface acting on the brick

$\vec{F}_g$ = Force of gravity acting on the brick

b) Draw a free body diagram for the brick as accurately as possible. Use your free body diagram to determine the net force vector graphically *(i.e. not components)*. Does your result agree with that predicted by Newton's second law for this situation?



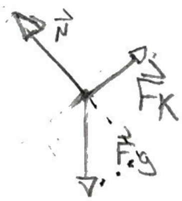
$\vec{N}$ = Normal force

$\vec{F}_k$ = Force of friction

$\vec{F}_g$ = Force of gravity

c) The same brick is on an inclined surface with the same slope but made of a different material. The brick moves down the surface with a constant speed.

i) List the forces acting on the brick and sketch a free body diagram for it.



$\vec{N}$ = Normal force

$\vec{F}_K$ = Force of friction

F_g = Force of gravity

ii) How does the frictional force exerted by the surface in this situation compare to that of part (a)? The same, different? Explain your answer.

It is kinetic friction in this instance which has a lesser magnitude than static friction

X

-1

iii) King Zog considers this situation and states: "The brick slides down the inclined plane because the force of its mass pulls it downwards." Is this correct? Explain your answer.

No this not correct because the kinetic friction results in a net force greater than zero.

iv) Queen Geraldine states: "The brick can only slide down while there is a non-zero net force acting on it." Is this correct? Explain your answer.

Yes this correct because at net force zero there is no acceleration and acceleration is necessary to have a force

d) A phone is suspended by a rope in an elevator. The elevator moves up with constant speed.

i) King Zog considers this situation and states: "The elevator exerts a force on the phone." Is this correct? Explain your answer.

No, the rope is exerting force on the phone.

ii) Queen Geraldine states: "The phone can only move up if the rope pulls up on the phone. If the rope snapped, the phone would immediately stop moving up and begin to fall." Is this correct? Explain your answer.

This is correct because the refrence frame has no acceleration and it can be considered at rest in the inertial reference frame.

iii) Prince Leka claims: "There is no difference in the force exerted by the rope when the elevator moves up with a constant speed versus down with a constant speed, even if the downward speed is different to the upward speed." Is this correct? Explain your answer.

There is no difference in between the two because of the lack of acceleration.

✓

iv) King Zog reconsiders the situation and states: "When the elevator accelerates down with acceleration smaller than g, the force exerted by the rope is larger than the gravitational force exerted on the phone." Is this correct? Explain your answer.

yes this true because acceleration will point in the opposite direction of tension and since the acceleration is smaller than g, the tension is bigger because it is moving downward.